IV. REMARKS

The present amendment is responsive to the Office Action dated March 19, 2004. Claims 1-13 are pending in the application but claims 6-8 have been withdrawn from consideration and remaining claims 1-5 and 9-13 have been rejected. The specification has been amended to correct obvious inconsistencies and amendments to the drawings are being presented for Examiner's consideration.

The present invention, as disclosed and claimed, relates to a full form net shape roll finished contacting machine element such as a gear or sprocket which is produced from a near net shape workpiece having an initial outer peripheral contoured surface and including a plurality of teeth, each having a tooth flank with a nominally involute surface and a root/fillet region with a trochoidal surface. A rolling die having an outer peripheral contoured surface including a plurality of teeth, each including a tooth flank with opposed involute surfaces and a tooth tip surface, is rotatably supported on a first axis. With the workpiece rotatably supported on a second axis distant from and parallel to the first axis, the rolling die is advanced in an in-feed direction generally perpendicular to the first and second axes such that the rolling die meshingly engages with the workpiece. Continuous conjugacy is maintained between the rolling die and the workpiece with the involute surface of each tooth of the rolling die engaging the involute surface of a mating tooth of the workpiece and the tooth tip of the rolling die engaging the trochoidal root/fillet surface between adjacent mating teeth of the workpiece. The rolling die continues to advance in the in-feed direction thereby deforming the surface of

each tooth flank and of a corresponding root/fillet region until a final net shape of each tooth and root/fillet region is achieved. This process continues for all of the teeth of the workpiece resulting in a final net shaped machine element.

The key aspect of the invention is the technique for roll finishing simultaneously in the active contacting surfaces and the root and fillet regions of gear teeth made of wrought and forged steels, so as to achieve controlled plastic deformation along the entire tooth surfaces. Such a technique of full form roll finishing of the gear teeth along the active contacting surfaces and the root/fillet regions results in improved surface finish, and when incorporated in conjunction with ausforming, results in improved strengthening, both along the tooth flanks for improved surface durability and in the critical root/fillet regions of gear teeth for enhanced bending strength.

The drawings have been: "... objected to as failing to comply with 37 CFR 1.84(p)(4)because reference character "62" has been used to designate both the radius of circumferential line 60 and constant velocity joints (see figures 1 and 2)." Examiner further commented:

> "A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance."

In response, a marked-up drawing providing a proposed correction accompanies this amendment and Examiner's approval is respectfully solicited. If approval is granted, a new formal drawing will be filed.

The drawings have been: "... objected to under 37 CFR 1.83(a) because they fail to show 'gear die 44' as described on page 10, line 2 in the specification." Examiner further commented:

> "Any structural detail that is essential for a proper understanding of the disclosed invention should be shown in the drawing. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance."

In this instance, the text has been amended to refer instead to rolling gear dies 30, 32 which are actually illustrated. No drawing correction is necessary.

Examiner further commented:

> "The disclosure is objected to because of the following informalities: on page 9, line 15, Applicant is required to assigned the proper reference numeral to the 'constant velocity joints', on page 10, line 2, 'gear die 44' is not found in the drawings.
> Appropriate correction is required."

Once again, in response, appropriate correction of the text has been made. It should be noted that reference numeral 62 continues to be correct such that no drawing correction is necessary.

Claims 1-5 and 9-13 have been rejected under 35 U.S.C. 103(a) "... as being unpatentable over Amateau et al. (US Patent 5,451,275) in view of Bregi et al. (US Patent 3,631,703)and Applicant's Admitted Prior Art (AAPA)." Examiner further commented:

> "With regards to claims 1-3, 5, 9-11 and 13, Amateau discloses all the claimed steps (see the disclosure of Amateau et al.) except for the tooth tip of the rolling die engaging the trochoidal root/fillet surface between adjacent mating teeth of the workpiece while the involute surfaces of the machine element are being finished rolled. However Bregi et al. teaches such step in roll finishing gears, see column 1, lines 44-71. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made, to have modified the tops of the teeth of the finishing rolling dies of Amateau et al. so that the teeth tips of its rolling die engage the trochoidal root/fillet surface while the involute surface is being finished, in light of the teachings of Bregi et al., in order to produce relief areas on the finished rolled machine element. Although Amateau et al./Bregi et al. does not disclose the gear being made of wrought or forged steel, however it is known to use wrought or forged steel in making gears as attested by Applicant's Admitted Prior Art at pages 1-4 of the specification to be known as AAPA. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made, to have used wrought or forged steel in the method of Amateau et al./Bregi et al., in light of the teachings of AAPA, in order to realize the benefits of using such known material.
> For claims 4 and 12, producing a sprocket is an obvious matter of article design choice since no alteration of the method results from this structural limitation."

U.S. Patent 5,451,275 to Amateau et al. was most certainly a huge step forward in the manufacture of consistently superior gears for high tech applications. In that patent, an apparatus and method are provided for the thermomechanical net shape finishing of precision gear tooth surfaces by controlled deformation into metastable austenitic condition. To this end, an arrangement of a fixed axis through-feed motion of workpiece and moving axes in-feed motion of two opposed rolling dies are utilized. By means of process control methods and architecture for accomplishing

precision mechanical motions, thermal and environmental control and timely and automatic transfer of workpiece, high strength and high accuracy gear tooth contact surfaces are produced.

In Bregi et al., a gear rolling die is disclosed in the form of a gear having teeth generally conjugate to the desired form of teeth on the work gear, but provided with protuberances adjacent the tips of the teeth to form undercuts adjacent the roots of the work gear. Preferably, in the Bregi et al. model, the die teeth are provided with inclined ramps adjacent the roots for engagement with the corners of the gear teeth provided by the intersections of the top and side surfaces of the teeth thereof. In gear production the undercuts are provided in rough rolling and form spaces into which material is displaced during finish rolling.

Accordingly, the invention of the Bregi et al. '703 patent involves incorporating a protuberance or added material near the die tooth tips in order to produce an undercut or a relief in the gear teeth below the contacting or working surfaces. The reason for producing the undercut by using such a protuberance is to provide a region for the material to flow from the gear tooth flanks during the roll finishing operation. Such an undercut may be required only in the case of excessive stock to be moved by the roll finishing process, which is not the case of our invention wherein the degree of material deformed is carefully controlled. Furthermore, the '703 patent also includes use of inclined ramps in the root/fillet regions of the rolling dies, in order to produce corresponding gear tooth tip chamfers. Clearly, the purpose of this patent is to achieve adequate finishing along

the gear tooth flanks only, and to provide spaces wherein material can flow both near the tips and in the root fillet regions. The purpose is not to achieve improved surface finish and strengthening in the trochoidal regions of the root/fillet, as is the case in the instant application. The invention of the present application does not use any protuberances or inclined ramps on the rolling dies and, therefore, this patent is not relevant to the technique of the present invention.

It is submitted, then, that Claims 1-5 and 9-13 are patentable over Amateau et al.(US Patent 5,451,275) in view of Bregi et al. (US Patent 3,631,703), and a finding to this effect is respectfully solicited.

Examiner also commented:

> "The prior art made of record and not relied upon is considered pertinent to applicant's disclosure."

Applicants have taken note of the Examiner's statement and while they generally agree with this contention, it is also submitted that the instances of the non-applied prior art either taken individually or in combination with any of the other art of record would not render unpatentable any of the claims presently in the application.

In light of the amendments to the specification, the proposed changes to the drawings, and the arguments presented, it is respectfully requested that the Examiner see fit to allow all of the claims under rejection, namely, claims 1-5 and 9-13, thereby enabling a patent to issue by an early date.

For all of the foregoing reasons, it is respectfully submitted that all of the claims now present in the application are clearly novel and patentable over the prior art of record, and are in proper form for allowance. Accordingly, favorable reconsideration and allowance is respectfully requested. Should any unresolved issues remain, the Examiner is invited to call Applicants' attorney at the telephone number indicated below.

The Commissioner is hereby authorized to charge payment for any fees associated with this communication or credit any over payment to Deposit Account No. 16-1350.

Respectfully submitted,

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